

Table 3–1. Properties of the Nakai Soil Type

Soil Name	Taxonomy	Depth (inches)	pH	Salinity (mmho/cm)
Nakai	Coarse-loamy, mixed, mesic Typic Calciorthids	40–>60	7.4–8.4	< 2
Permeability (inches/hour)	Available Water (percent)	Textural Class	Clay (percent)	Erodibility Factors ^a
2.0–6.0	10–16	Fine sandy loam to loamy fine sand	10–18	K = 0.28 T = 3 Wind = 3

^aErodibility factors: “K,” used in the Universal Soil Loss Equation, is an indicator of the susceptibility of a soil to sheet and rill erosion by water. Values range from 0.02 to 0.69; the higher the value, the more susceptible the soil is to sheet and rill erosion. “T” is an estimate of the maximum average annual rate of water or wind erosion in tons per acre per year.

Wind erosion factors range from 1 to 8; the lower the value, the more susceptible the soil is to wind erosion.

mmho/cm = millimhos per centimeter.

Source: SCS 1989.

3.1.3 Description of Contaminated Materials at the Moab Site

3.1.3.1 Millsite Contamination

In 2001, DOE began radiometric characterization of soils on the millsite. To date, the area north and northeast of the tailings pile have been assessed. Most of the site has soil contamination exceeding EPA standards for radium-226 except for small areas north of the tailings pile and one larger area northwest of the pile where a borrow pit was excavated and soils were used for pile surcharge (i.e., weight on the pile to squeeze out moisture) and for the interim cover. Shallow contamination was also identified north of US-191 on DOE property extending to the property line with Arches National Park.

Depths of contamination range from 6 to 120 inches. The area outside the tailings pile (i.e., the area of windblown contamination) is estimated to contain 71,000 yd³ of contaminated soils. Measuring the depth of contamination with surface scanning and downhole logging instruments has inherent uncertainties; experience at other UMTRCA sites suggests that the final volume could exceed the volume characterized by a range of 50 to 100 percent.

Additional data collected also suggest that contamination occurs elsewhere on the site. Preliminary surface scans by DOE show contamination between the railroad and SR-279 and also near the abandoned ore-loading station adjacent to the rail tracks. Preliminary scans also show elevated gamma levels southeast of the tailings pile in the tamarisk. However, statistical sampling performed to minimize cutting of the tamarisk between the property fence and the Colorado River indicates that radium-226 concentrations in the area may not exceed EPA standards. A 1980 survey performed for Atlas Corporation (Ford, Bacon & Davis 1979) suggests that contamination does not extend across SR-279 to the southwest and up the steep hillside. A 1982 aerial survey performed by a DOE contractor (EG&G) did not provide any additional data on millsite contamination.

On the basis of site knowledge and past UMTRCA site experience, DOE estimates that 11.9 million tons (8.9 million yd³) of contaminated materials exist at the Moab site and vicinity properties.

Table 3–2 presents a summary of the contaminated materials and quantities present at the Moab site and nearby vicinity properties. On the basis of sampling results, Table 3–3 shows the percentages of tailings by type believed to be present in the Moab tailings pile. Additional investigations confirmed that most of the slimes are located in the center of the pile and are surrounded by sandy tailings.

Table 3–2. Contaminated Material Quantities

Source Material	Volume (yd³)	Weight (dry short tons)
Uranium mill tailings	7,800,000	10,500,000
Pile surcharge	445,000	600,000
Subpile soil	420,000	566,000
Off-pile contaminated site soils	173,000	234,000
Vicinity property material	29,400	39,700
Total	8,867,400	11,939,700

Table 3–3. Percent of Tailing Types in the Moab Impoundment

Material	% Passing No. 200 Sieve	Percentage of Total Tailings
Sand	Less than 30	7
Slimey-sands	Greater than 30; less than 50	20
Sandy-slimes	Greater than 50; less than 70	23
Slimes	Greater than 70	49

The tailings pile at the site contains the waste residuals from the milling operation. Milling involved both acid and carbonate processing methods (i.e., circuits). Lime was added to the tailings to neutralize the acid-milled tailings. Chemicals used in the processing, including acids, ammonia, and solvents, are incorporated with the silicate grains. Many other minerals, including sulfates and sulfides, are also present in lesser amounts. It is difficult to determine the residence time of the contaminants, although there is evidence that some exist as siliceous mixtures, and others may exist as sulfides, selenides, molybdates, and uranium minerals. Contaminants are also likely to be adsorbed to minerals, especially iron oxyhydroxides.

Bulk chemical analysis of the tailings solids indicates that high concentrations of ammonia, uranium, and radium-226 are present. The mean radium-226, ammonia (as N), and uranium concentrations for the tailings are 516 pCi/g, 423 milligrams per kilogram (mg/kg), and 84 mg/kg, respectively. The finer grained (slimes and silt) fractions have more radium-226 and uranium but less ammonia as (N) than the sand fraction. Other constituents, including iron, manganese, copper, lead, molybdenum, and vanadium, are present in lesser amounts. The pH values of the tailings are near neutral but have zones of pH values as low as 2.5 and as high as 10. The tailings have a small amount of acid-generating capacity in the form of sulfide minerals. The oxidation-reduction potential is not well defined by existing data, and conditions may vary spatially from relatively oxidizing to relatively reducing.

Mean tailings pore water concentrations for radium-226 and uranium are 61.1 picocuries per liter (pCi/L) and 15.1 mg/L, respectively. The average tailings pore water concentration for ammonia (as N) is 1,100 mg/L. Pore water is a mixture of residual milling fluids and water that infiltrated later into the tailings. The pore water appears to be relatively oxidized, although few data are available to assess oxidation-reduction potential. The pH value of the pore water is near neutral, and the mean TDS concentration is 23,500 mg/L. Values of pH, oxidation state, and availability of soluble minerals in the tailings are the main parameters that affect the composition of pore water. Concentrations of organic constituents used in the mill processing circuit are negligible in the pore water. Concentrations of all constituents are much higher in samples of water collected in a shallow-depth sump fed by pore water extracted from the tailings through wick drains than in any of the pore water samples collected from deeper SRK (2000) wells. Analysis of samples collected from the sump indicate the presence of a salt layer in the upper portion of the pile (DOE 2003).

Two underground septic tanks (size unknown) that supported past operations but are no longer used are located inside the radioactively contaminated portion of the site northeast of the historical warehouse. It is unknown if there are buried leach fields associated with these tanks. Organic contamination in soil and ground water samples was not detected by DOE in an analysis performed as part of the site characterization for the SOWP (DOE 2003).

3.1.4 Air Quality

EPA has established NAAQS for sulfur dioxide, nitrogen dioxide, carbon monoxide, ozone, lead, and particulate matter (particles less than 10 micrometers [μm] in aerodynamic diameter, designated PM_{10}) small enough to move easily into the lower respiratory tract. NAAQS are expressed as concentrations of particular pollutants that are not to be exceeded in the ambient or outdoor air to which the general public has access (40 CFR 50.1[e]). Primary NAAQS are designated to protect human health; secondary NAAQS are designated to protect human welfare by safeguarding environmental resources (such as soils, water, plants, and animals) (Table 3–4). Utah has adopted NAAQS as the air quality standards for the state.

Table 3–4. Air Quality Standards

Pollutant	Averaging Period	National and State Ambient Air Quality Standard ($\mu\text{g}/\text{m}^3$) ^a		Allowable Increment for Prevention of Significant Deterioration (PSD) ^a ($\mu\text{g}/\text{m}^3$)	
		Primary	Secondary	Class I	Class II
Sulfur dioxide	Annual	80	–	2	20
	24-hour ^b	365	–	5	91
	3-hour ^b	–	1,300	25	512
Nitrogen dioxide	Annual	100	100	2.5	2.5
Carbon monoxide	8-hour ^b	10,000	–	–	–
	1-hour ^b	40,000	–	–	–
Ozone	1-hour ^b	235	235	–	–
PM_{10} ^c	Annual	50	50	4	17
	24-hour ^b	150	150	8	30
Lead	3-month ^d	1.5	1.5	–	–

^a $\mu\text{g}/\text{m}^3$ = micrograms per cubic meter; where no value is listed, there is no corresponding standard.

^bNot to be exceeded more than once per year (for ozone and PM_{10} , on more than 1 day per year on the average over 3 years).

^cParticulate matter less than 10 μm in diameter.

^dCalendar quarter.